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ABSTRACT

Since measurement errors exist in panel surveys, LISREL (a procedure for controlling measurement error by the analysis of covariance structures) was used in this investigation to determine the stability of the social-psychological concept of locus of control expectancy change with the aquisition of post secondary education. The National Longitudinal Study of the High School Class of 1972 made a survey of 22,652 seniors in 1,318 public and private high schools. A subset of the data on 8,650 white males was used for this study. The measures of the locus of control, based on Rotters' Scale, were used twice, once in the students' senior-year and again four years later. The variables of ability and socio-economic status were also incorporated into the study. Apparently the acquisition of further education beyond high school does not substantially increase one's internal control expectancies. Parallel results are to be found in a study on self-esteem made by Bachman, O'Malley and Johnston (1978). Data are presented in tabular form throughout the study. (Author/AEF)

LATENT CAUSAL STRUCTURES IN PANEL SURVEYS*

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ABSTRACT

The primary purpose of this investigation was to determine the stability of the social-psychological concept of locus of control, and to measure the extent to which locus of control changes with the acquisition of post-secondary education. Because of our concern that measurement errors, which surely exist, will affect naive measures of stability and change, we eschew the common regression approach in favor of LISREL, a general method for the analysis of covariance structures quite appropriate for the analysis of panel survey data.

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The characteristic feature of panel surveys is that the same measurements are obtained from the same people on two or more occasions. The usual purpose is to measure the changes that occur between the several occasions, and to attribute these changes to events or treatments occurring between surveys, while controlling for the spurious effects of background characteristics. In the presence of measurement error, however, an almost universal condition, regression estimates will be biased unless some procedure is employed to obtain estimates net of measurement error. If, for example, the errors of measurement of a particular variable measured on two occasions are completely random, then the estimated coefficient of stability will be reduced; that is, the effect of some characteristic measured at another point in time will be underestimated, and one would incorrectly assume there existed more change than in fact occurred. If random errors exist among background variables, the estimated coefficient of stability between two measures of one variable would be increased, because their mutual dependence upon the background variables would be underestimated. Furthermore, the estimated effects of background variables will be either inflated or deflated if the background variables have been measured with differential reliabilities, and will be further

compounded if the errors of measurement are not random, but are correlated with each other. Unfortunately, it is reasonable to suspect that all these types of error affect the measurement of social variables. Because neither the direction nor magnitude of the biases may be known *a priori*, there is no way to assess the biases in regression models of social change.

Fortunately, there now exists an analytic procedure which uses maximum likelihood estimation procedures to estimate confirmatory factor analysis measurement models. The resulting variances and covariances of the latent factors are then used to estimate a hypothesized causal structure among the latent factors. The resulting estimates of effects among latent factors have been corrected for differential measurement errors (but see Alwin and Jackson, 1979), and thus do not suffer the biases produced by naive regression models. The computer program which produces the corrected estimates is called LISREL; the mathematical papers which led to its development have been collected by Jöreskog and Sörbom (1979); and the operation of the program is presented in Jöreskog and Sörbom (1978).

To illustrate these issues substantively, a latent causal model was estimated to measure the stability and change in locus of control. The social-psychological concept of locus of control is an outgrowth of social learning theory, and has been thoroughly discussed by Rotter (1966). Those who are self-directed and perceive themselves as the primary determiners of their own fate are said to hold internal control expectancies. Those who perceive chance or fate as the primary determinants of their destinies are said to hold external control expectancies (Lefcourt, 1976). An internal orientation has been found to be positively associated with

such psychological adjustment indicators as resistance to influence, the ability to defer gratification, infrequent feelings of helplessness, and the ability to cope with failure (Lefcourt, 1976).

Although locus of control is fairly stable over time, it has been found to change in certain naturally occurring situations as well as experimentally induced ones. One of the more influential interventions is the acquisition of higher status. Harvey (1971), for example, has demonstrated that upward status mobility is associated with shifts in locus of control toward the internal direction. It comes as no surprise that different environments, experiences and social conditions lead to variations in personality characteristics. Those who acquire an increased capacity to affect their circumstances by virtue of their social standing are those who express high degrees of internal control. Yet it is also commonly assumed that variations in personality characteristics lead people to expose themselves to different social environments. Thus, part of the association between upward mobility and personality characteristics may be due to the same personality characteristics affecting mobility. The causal linkage between status mobility and locus of control is thus a two-way street; those whose locus is toward the internal direction are those who acquire the educational and occupational standing which leads to their internalized locus of control.

Several studies have investigated the effects of socioeconomic achievement on personality characteristics. For example, Featherman (1972) found that two concepts, work orientation and materialistic orientation, both increased with the acquisition of additional years of schooling. It may be important, however, before attributing changes in psychological constructs

to socioeconomic achievement, to control for earlier levels of the psychological contructs. One study that did was Bachman, O'Malley and Johnston's (1978) examination of educational attainment and self-esteem. They found that educational attainment did not affect self-esteem net of previous self-esteem levels.

Our interests are similar. What are the effects of educational attainment on the social-psychological concept of locus of control? Is the relationship between these variables causal, or does it exist because they mutually depend upon common antecedent causes, particularly earlier expressions of locus of control? Because of our concern that measurement errors, which surely exist, will affect regression estimates, we eschew the more common regression approach. Instead, we address these questions with a relatively new analytic procedure, LISREL. (For those who are unfamiliar with LISREL, see Jöreskog and Sörbom, 1978; and Wolfle, 1981.)

THE MODEL

Of primary interest is the stability of the social-psychological construct of locus of control. Furthermore, this analysis addresses the question of whether attendance at a post-secondary institution increases internality, and to what extent prior levels of an internal locus of control leads one to attend a post-secondary institution. It is not enough, however, to examine the effect of prior measures of locus of control on the decision to attend college without controlling for other antecedent variables. Thus, we introduce into the analysis two exogenous variables, ability and socioeconomic status of the family of origin. Both of these variables have been shown to influence educational attainment

(e.g., Blau and Duncan, 1967; Hauser, 1973). Moreover, ability is known to influence locus of control (Crandall, et al., 1962; Chance, 1965; Crandall, et al., 1965), as is socioeconomic status (Strodtbeck, 1958; Battle and Rotter, 1963; Franklin, 1963; Stephens and Delys, 1973).

Ability and socioeconomic status were considered to be exogenous, and were hypothesized to be causally prior to, and predictive of, locus of control measured prior to high school graduation, attendance at a post-secondary institution, and locus of control measured four years after graduation from high school. The earlier measure of locus of control was hypothesized to influence college attendance, and the later measure of locus of control. College attendance was hypothesized to have a positive effect upon the later measure of locus control, reflecting a move toward more internal control expectancies.

These relationhips are shown in Figure 1, in which variables enclosed in ellipses are latent constructs, such as locus of control, while unenclosed variables with mnemonic names are manifest variables used as imperfectly measured indicators of the underlying factors. A formal expression of the relationships depicted in Figure 1 may be achieved by using the algebraic notation employed in LISREL.

If one symbolizes the latent socioeconomic factor by ξ_1, and lets ξ_2 = latent ability; and x_1 = father's educational attainment, x_2 = mother's educational attainment, x_3 = father's occupational status, x_4 = vocabulary test score, x_5 = reading test score, x_6 = letter-group test score, and x_7 = math test score; then:

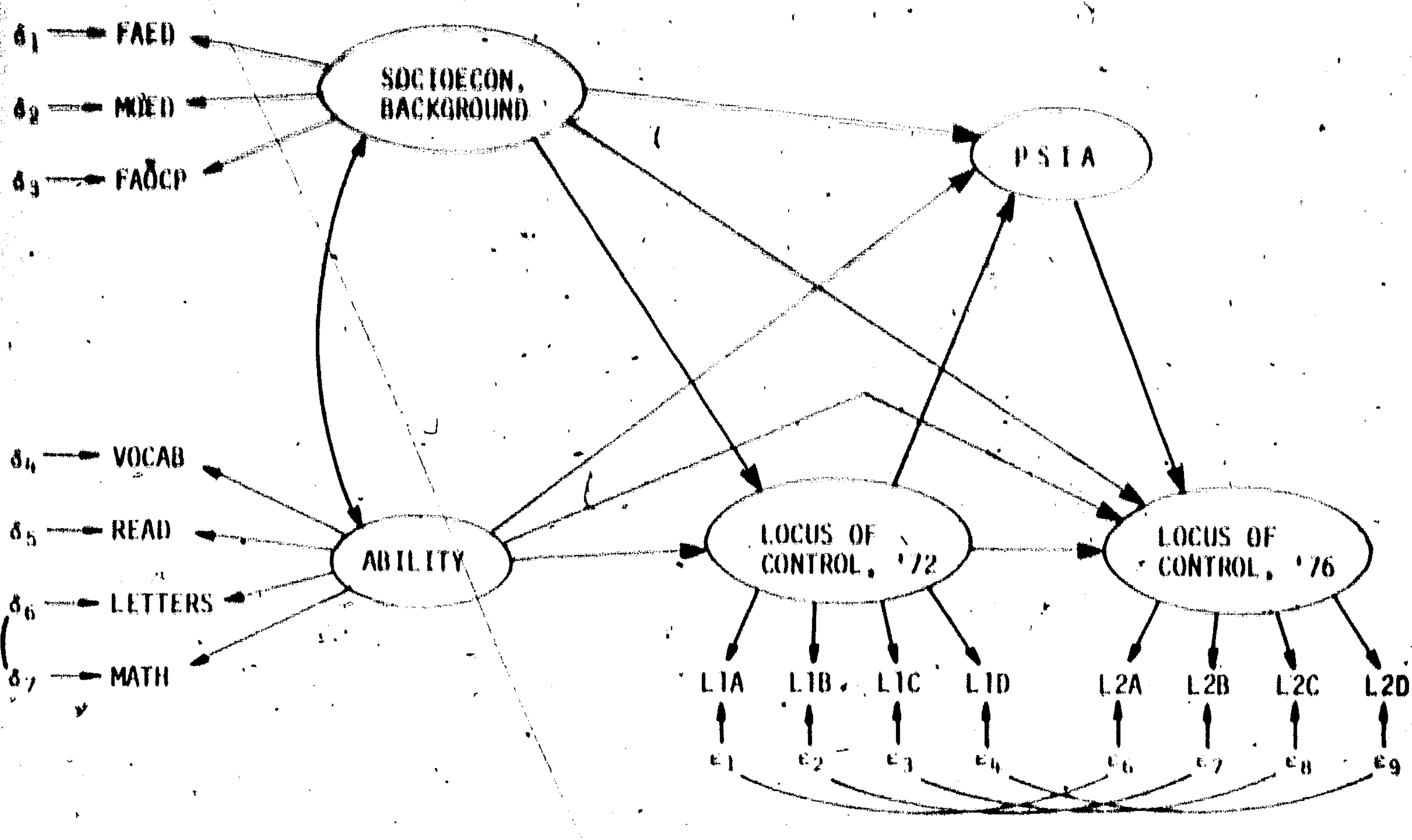

Figure 1. Model of Stability and Change in Locus of Control

$$x_1 = \lambda_{11}\xi_1 + \delta_1$$
$$x_2 = \lambda_{21}\xi_1 + \delta_2$$
$$x_3 = \lambda_{31}\xi_1 + \delta_3$$
$$x_4 = \lambda_{42}\xi_2 + \delta_4$$
$$x_5 = \lambda_{52}\xi_2 + \delta_5$$
$$x_6 = \lambda_{62}\xi_2 + \delta_6$$
$$x_7 = \lambda_{72}\xi_2 + \delta_7$$

in which δ_i are errors of measurement, which include both specific and random components of variation. The variance-covariance matrix among the δ_i, Θ_δ, is initially assumed to be a diagonal matrix, which implies that these errors are uncorrelated with each other, but this assumption may be relaxed without loss of generalization.

Furthermore, if η_1 = locus of control, η_2 = college attendance, η_3 = later locus of control; y_1 through y_4 are four manifest measures of locus of control to be described below, y_5 = a dummy variable which equals 1.0 if the respondent attended college, and zero otherwise, y_6 through y_9 are four measures of locus of control measured four years after high school graduation; then:

$$y_1 = \lambda_{11}\eta_1 + \varepsilon_1$$
$$y_2 = \lambda_{21}\eta_1 + \varepsilon_2$$
$$y_3 = \lambda_{31}\eta_1 + \varepsilon_3$$
$$y_4 = \lambda_{41}\eta_1 + \varepsilon_4$$
$$y_5 = \eta_2$$

$$y_6 = \lambda_{63}\eta_3 + \epsilon_6$$

$$y_7 = \lambda_{73}\eta_3 + \epsilon_7$$

$$y_8 = \lambda_{83}\eta_3 + \epsilon_8$$

$$y_9 = \lambda_{93}\eta_3 + \epsilon_9$$

in which ϵ_i are errors of measurement. These errors are at first assumed to be uncorrelated, but it seems unreasonable to assume the errors of y_1, say, are uncorrelated with those of y_6, since these are the same variables measured at two different times; a statistical test will be made to determine if these correlations are or are not zero.

These two sets of equations define the measurement portion of the LISREL model. The structural portion is defined by the equations:

$$\eta_1 = \gamma_{11}\xi_1 + \gamma_{12}\xi_2 + \zeta_1$$

$$\eta_2 = \gamma_{21}\xi_1 + \gamma_{22}\xi_2 + \beta_{21}\eta_1 + \zeta_2$$

$$\eta_3 = \gamma_{31}\xi_1 + \gamma_{32}\xi_2 + \beta_{31}\eta_1 + \beta_{32}\eta_2 + \zeta_3$$

in which ζ_i are components of the endogenous variables that are not explained by the linear combination of the independent variables.

The parameters of the model are estimated by the method of maximum likelihood, on the assumption that the manifest variables have a joint multivariate normal distribution.

DATA AND MANIFEST VARIABLES

The data for this research were taken from the National Longitudinal Study of the High School Class of 1972 (see Levinsohn, et al., 1978). The NLS was designed to provide data on the development of educational,

vocational, and personal aspects of the lives of adolescents as they make the transition from high school to the adult world. The NLS sample was a two-stage stratified national probability sample of 22,652 seniors from 1318 public and private high schools.

The analysis reported in this paper is based on a subset of the NLS data set. By restricting our analysis to 8,650 white males, we avoid confounding the results with differences in locus of control known to exist between blacks and whites (Lessing, 1969; Owens, 1969; Shaw and Uhl, 1969; Zytkoskee, et al., 1971; Strickland, 1972) and between men and women (Feather, 1967, 1968; Brannigan and Tolor, 1971; Roodin, et al., 1974; Zerega, et al., 1976). The parameters in the model were estimated from pairwise present correlations, which are shown in Table 1.

The manifest measures of locus of control were based on a short form of Rotter's (1966) scale, and consisted of four items, each with four response options ranging from "disagree strongly" to "agree strongly." Items were scored so that disagreement indicated internal locus of control and received the larger numeric values. Lower scores therefore indicated an external orientation. The four items were:

A. Good luck is more important than hard work for success;

B. Every time I try to get ahead, something or somebody stops me;

C. Planning only makes a person unhappy since plans hardly work out anyway;

D. People who accept their condition in life are happier than those who try to change things.

TABLE 1. Correlations, Means and Standard Deviations among Variables in a Model Predicting Locus of Control: White Male 1972 High School Graduates (N=8650)

Variables	L1A	L1B	L1C	L1D	L2A	L2B	L2C	L2D	PSIA	FAED	MOED	FAOCP	VOCAB	READ	LETTERS	MATH
L1A																
L1B	.185															
L1C	.243	.387														
L1D	.125	.201	.273													
L2A	.215	.079	.104	.039												
L2B	.106	.268	.197	.154	.252											
L2C	.136	.163	.260	.127	.282	.461										
L2D	.085	.094	.139	.272	.194	.259	.356									
PSIA	.091	.186	.182	.168	.019	.205	.159	.152								
FAED	.039	.128	.120	.107	.005	.162	.136	.098	.308							
MOED	.050	.126	.110	.107	.013	.144	.118	.087	.258	.535						
FAOCP	.045	.110	.100	.106	.004	.127	.097	.079	.234	.548	.366					
VOCAB	.098	.186	.175	.286	.008	.209	.157	.200	.339	.288	.263	.229				
READ	.150	.201	.199	.305	.033	.214	.180	.211	.353	.269	.253	.217	.648			
LETTERS	.143	.181	.172	.196	.060	.196	.167	.163	.309	.220	.189	.183	.428	.532		
MATH	.142	.218	.191	.233	.056	.239	.193	.172	.408	.274	.237	.233	.535	.629	.668	
MEAN	3.279	2.870	3.007	2.803	3.244	3.079	3.238	3.028	.632	12.023	11.881	43.608	51.659	51.548	50.662	53.040
S.D.	.680	.713	.778	.917	.657	.711	.706	.811	.482	3.400	2.810	23.028	9.700	9.497	9.427	9.488

These items were asked once during the respondents' senior year of high school, and again in the fall of 1976. The labels given these items in Table 1 and Figure 1 are L1A, L1B, L1C, and L1D for the initial survey, and L2A, L2B, L2C, and L2D for their respective remeasurement in 1976.

Attendance at a post-secondary institution (PSIA) was measured with a single manifest indicator, assumed to be measured without error. In 1976, the NLS respondents were asked how much schooling they had obtained since graduating from high school. If a person had obtained any post-secondary schooling from a four-year college or university, a two-year college, or a vocational, technical or business school, he received a score of 1.0; if he had obtained no schooling beyond high school, he received a score of zero.

The observed variables used as indicators of socioeconomic background were father's education (FAED), mother's education (MAED), and father's occupational status (FAOCP). Father's and mother's educations were based on NLS composite scales, and were measured in years of schooling. Father's occupational status was also based on an NLS composite variable, and was scaled by the Duncan (1961) socioeconomic index as adjusted to the 1970 census occupational code (Hauser and Featherman, 1977).

The latent ability factor was hypothesized to underlie performance on four ability subtests administered in the spring of 1972. The four indicators used in this analysis were the vocabulary (VOCAB), reading (READ), letter-group (LETTERS), and mathematics (MATH) subtests.

LOCUS OF CONTROL: STABILITY AND CHANGE

Assuming the joint distribution of the 16 variables in the model is multivariate normal, maximum likelihood estimates of parameters in the 19 structural and measurement model equations were obtained using Jöreskog and Sörbom's (1978) LISREL program. When the parameter estimates were obtained, a X^2 goodness-of-fit statistic was calculated comparing the covariance matrix implied by the equations to the observed covariance matrix. This statistic may be regarded as a test of the specific model against the most general alternative that the estimated variance-covariance matrix is any positive matrix. When sample sizes are large, however, it is common to find large values of X^2 relative to the degrees of freedom. In such cases it is suggested (see Bentler and Bonett, 1980) to fit a more restrictive model as against a less restrictive model, and to compare the resulting two X^2 measures. The difference between the two likelihood-ratio X^2 measures is approximately distributed as X^2 with degrees of freedom equal to the difference in the number of independent parameters in the two models. If there is a large decrease in X^2 from one model to the other relative to the difference in degrees of freedom, then the changes made in the more restrictive model represent a real improvement in fit.

The summary measures of goodness-of-fit are shown in Table 2. Model A of Table 2 assumes the errors of measurement are entirely random, and imposes a recursive causal structure among the latent factors as shown in Figure 1. The likelihood-ratio X^2 value for this model is 1563.80 with 95 degrees of freedom, which suggests that the assumption of random errors is untenable. (Note that the lack of fit must be found in the measurement

Table 2. Goodness-of-Fit Statistics for Models of Stability and Change in Locus of Control.

Model	X^2	d.f.	Prob.	ΔX^2	d.f.	Prob.
A. Random errors	1563.80	95	0.0			
B. Locus of control errors free	1105.41	91	0.0	458.39	4	0.0
C. Locus of control errors free; math-letters error free	643.75	90	0.0	461.66	1	0.0

model, because the structural model is just identified.)

It is well known that when the same measuring instrument is used on two or more occasions, there is a tendency for the errors in each variable to covary over time because of memory or other retest effects. Accordingly, Model B was estimated with the errors for each of the four locus of control indicators allowed to covary with their equivalent error terms for the questions repeated in the subsequent panel. Comparison of the fit of this model to that of Model A yields a X^2 difference of 458.39 with 4 degrees of freedom. This is a major improvement in fit, and suggests that one would be well advised to consider the possibility of correlated errors in panel surveys.

It is appropriate to pause here to consider the effect of correlated errors on estimates of stability between the underlying factors of locus of control. The structural coefficient from the locus of control factor at time 1 to the equivalent factor at time 2 in the model of random errors was .445; when the errors of the locus of control indices were allowed to covary, the stability coefficient was reestimated to be .335. That is, the model which assumed random errors overestimated the stability in locus of control by nearly a third -- a considerable bias. This brief aside should further sensitize one to consider the possibility of correlated errors in panel surveys; failure to do so may lead to gross overestimates of the stability of social constructs.

It is possible, of course, for there to be other sources of covariation among errors of measurement. An examination of the first-order derivatives among the measurement error matrices produced by Model B suggested that the covariation between the errors of the letter-group

and math subtests of ability was the fixed value which if set free would give the largest decrease in the fitting function. Accordingly, this value was designated in Model C to be a free parameter to be estimated by the program. The difference in X^2 values between Models B and C was 461.66 with one degree of freedom -- a major improvement in fit.

It was at this point that we discontinued our search for a better fitting model. In actuality, several other models were estimated, with successively more error terms set free, but the increments in X^2 values while statistically significant were not large. Because X^2 is known to be quite sensitive to small deviations from perfect fit with large samples, and because the structural-parameter estimates varied hardly at all from those of Model C, we adopted Model C as the best model for these data.

Measurement Model

The measurement model parameter estimates for the model of stability and change in locus of control are shown in Table 3. Several features of these estimates are noteworthy. Like Wolfle (1981), we find father's education to be the most reliable indicator of socioeconomic background, and the math and reading subtests generally to be the more reliable indicators of ability. Unlike Wolfle (1981), who found no evidence that the errors of measurement for these variables were correlated, we found some evidence to the contrary, particularly as noted above for the math and letter-group subtests of ability. Among the indicators of locus of control, the more reliable indicators were those items on getting ahead (L1B and L2B) and planning makes a person unhappy (L1C and L2C). These observations notwithstanding, the general level of reliability for locus

Table 3. Model C Measurement Parameter Estimates

Latent Factor	Manifest Variable	True Score Variance	Error Variance	Relative Slope	Reliability Coefficient
Socioeconomic Background	FAED	1.0*	.269	.855	.73
	MOED		.610	.624	.39
	FAOCP		.601	.632	.40
Ability	VOCAB	1.0*	.440	.748	.56
	READ		.286	.845	.71
	LETTERS		.619	.617	.38
	MATH		.443	.746	.56
Locus of Control, 1972	L1A	1.0*	.876	.358	.13
	L1B		.693	.550	.30
	L1C		.592	.641	.41
	L1D		.803	.442	.20
Locus of Control, 1976	L2A	1.0*	.860	.372	.14
	L2B		.589	.642	.41
	L2C		.481	.721	.52
	L2D		.775	.472	.22

* Fixed parameter.

of control is not very great. The reliabilities are, however, generally larger in value than Wolfle (1981) reported for some other social-psychological constructs developed from the same data set.

Structural Model

The main aim of this investigation was to determine the stability of locus of control, and to measure the extent to which locus of control changes with the acquisition of post-secondary education. These determinations are made with reference to Table 4. The correlation between the two locus of control factors, measured by a separation of four years, was .442. Of this value, about one-quarter is a spurious component due to their mutual dependence upon the respondent's ability and socioeconomic background. Most of the zero-order association is a causal effect of one's previous locus of control orientation on their later expression of the concept. Thus, locus of control is not very stable -- the correlation is only .442 -- but over 75 percent of the association is a direct effect of the earlier measure on the later.

The second main question addressed by the structural model is the extent to which college attendance increases one's internal control expectancies. The correlation between post-secondary attendance and locus of control in 1976 was .252, but only 20 percent of this may be said to be a direct effect of college attendance on locus of control; the remainder is spuriously due to the mutual dependence of college attendance and locus of control in 1976 on their antecedent causes -- primarily the earlier measure of locus of control and ability.

Table 4. Model C Standardized Parameter Estimates (standard errors in parentheses).

Dependent Factors	Predetermined Factors				R^2
	Socioeconomic Background	Ability	Locus of Control, 1972	Post-Secondary Attendance	
Locus of Control, 1972	.063 (.023)	.452 (.031)	---	---	.23
Post-Secondary Attendance	.206 (.017)	.319 (.020)	.106 (.021)	---	.26
Locus of Control, 1976	.071 (.022)	.145 (.026)	.337 (.034)	.054 (.020)	.23

CONCLUSION

Bachman, O'Malley and Johnston (1978) found that self-esteem in a 1966 cohort of high school seniors was correlated at .42 with the same measure four years later. They investigated the effect of educational attainment on self-esteem, and found that education beyond high school had little or no effect. In a surprising parallel, we have reached the identical conclusion about the concept, locus of control. Apparently the acquisition of further education beyond high school does not substantially increase one's internal control expectancies. The recent entry of this high school cohort into the labor market between 1972 and 1976 has precluded our extension of the analysis to the examination of the extent to which occupational standing affects locus of control. Future analyses may find that occupational status has more to do with one's feelings of internal control than does educational attainment.

Finally, we think our research has demonstrated the importance of obtaining estimates of stability and change net of measurement error. A common circumstance in panel survey data is to find correlated errors of measurement for the same indices measured on different occasions. Without some means such as the LISREL procedure employed herein for controlling measurement error, parameters of stability will likely be overestimated. If researchers are to engage seriously in the study of social change, they should no longer depend on naive analytic procedures that fail to deal realistically with measurement error.

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